North Coast Watershed Assessment Program

Gualala Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

DRAFT

Executive Summary of Findings and Conclusions

An Interdisciplinary and Interagency approach to Watershed Assessment on California's North Coast

Introduction

This report constitutes a first public review draft of the North Coast Watershed Assessment Program's (NCWAP) watershed assessment work on the Gualala River basin. The North Coast Watershed Assessment Program (NCWAP) was established in 2000 to provide a consistent scientific foundation for collaborative watershed restoration efforts and to better meet the State needs for protecting and restoring salmon. The program was developed as an interagency effort by the California Resources Agency and CalEPA, and includes the Departments of Fish and Game (DFG), Forestry and Fire Protection (CDF), Conservation's Division of Mines and Geology (DMG), and Water Resources (DWR), and the State Water Resources Control Board's North Coast Region (NCRWQCB). The Institute for Fisheries Resources is a contractor to CDF assisting in the development of a computerized database adapted from the Klamath Resource Information System (KRIS). The process also involved scoping and interaction with the Gualala River Watershed Council (GRWC), Gualala Redwoods, Inc. (GRI), and landowners in the watershed. This report is designed to begin to assess watershed conditions as they relate to a set of critical questions about suitability for salmon habitat, tailoring the assessment process to those that are most relevant to each watershed. Its contents should be considered preliminary and subject to review and revision. A final watershed assessment report is to be completed in May 2002.

Profile of the Gualala River Watershed Basin

The Gualala River flows through its 298 square mile watershed along the coast of southern Mendocino and northern Sonoma Counties, entering the Pacific Ocean near the town of Gualala. The Gualala River watershed is elongated, running over 32 miles long north to south . Elevations vary from sea level to 2,602 feet at Gube Mountain and terrain is most mountainous in the northern and eastern parts of the basin. The five principal subbasins of the Gualala are the Wheatfield Fork, South Fork and Gualala Mainstem, North Fork, Buckeye Creek, and Rockpile Creek.

Coastal conifer forests of redwood and Douglas fir occupy the northwestern, southwestern and central portions of the watershed while oak-woodland and grassland cover many slopes in the interior basin. Coho naturally inhabited the streams flowing from coniferous forest but were likely sub-dominant to steelhead in interior basin areas
A long history of movement along the San Andreas Fault and the Tombs Creek Fault has been a dominant force in the shaping of the basin. The climate is influenced by fog near the coast with seasonal temperatures ranging between 40 to 60 degrees F, but the interior basin can range from below freezing to over 90 degrees F seasonally. Rainfall also varies by location within the basin with 31 inches falling on average near the town of Gualala and totals reaching over 65 inches in some areas.

Ninety-five percent of the Gualala watershed is privately owned. The watershed has supplied timber since before 1900, the first wave of harvests occurring around the turn of the century. The next most significant wave occurred in the 1950s and 1960s with the advent of tractor yarders. Harvest operations concentrated in riparian areas. Logging roads often followed streams. Tractors pushed logs and dirt into streams to make road crossings and landings. Accelerated erosion from those logged areas was especially pronounced during the 1964 storm. Natural clearings as well as human-cleared areas on the eastern side of the watershed are used for grazing, though to a lesser extent since the 1980s. Residential development near the coast and vineyard development inland have become dominant land use activities since the late 1990s.

Salmon , Stream, Watersheds, and Land Use

Anadromous Pacific salmonids spend over half their life history in the marine environment, which is generally beyond man's control other than to regulate harvest. However, they are also dependent upon a high quality freshwater environment at the beginning and end of their life cycles. As such, they thrive or perish depending upon the availability of cool, clean water, free access to migrate up and down their natal streams, clean gravel for successful spawning, adequate food supply, and protective cover to escape predators and ambush prey. These life requirement conditions can be identified and evaluated on a spatial and temporal basis at the stream reach and watershed levels. They comprise the factors that support or limit salmonid stock production.

The anadromous salmonid fisheries historically included coho (*Oncorhynchus kisutch*), possibly Chinook salmon (*Oncorhynchus tshawytscha*), and steelhead trout (*Oncorhynchus mykiss*). Surveys in 1970 found significantly higher numbers of salmonids in the streams surveyed as compared to current conditions. Electrofishing was used to sample presence and absence of salmonids in all the basins except Rockpile during September, 2001. Coho were not observed in the watershed in 2001 and were last observed in the Northfork subbasin in 1998.

Assessment and Analysis

The assessment process included defining the factors and corresponding ranges which could limit salmonid populations in the watershed, such as water temperature, spawning gravel composition, etc. Those ranges came from the literature, DFG's California Salmon Stream Habitat Restoration Manual, and the NCRWCB's *Water Quality Control Plan for the North Coast Basin* (1996) (Basin Plan). Instream data were compared to those ranges, and a decision support model was run with the data using those ranges to provide a perspective on overall stream reach and watershed conditions.

The California Department of Fish & Game inventoried over 100 miles of stream for salmonid habitat throughout the watershed from June-November, 2001. Streambed substrate and embeddedness varied by subbasin and was dominated by gravel. The earliest stream surveys recorded higher pool frequency and depth, and longer reaches of suitable spawning gravels. Post 1950's and 1960's era logging surveys documented a shallow pool structure, reduced pool frequency and water quality problems related to logging debris deposited into streams. Habitat inventories showed low pool frequency and shallow pool depth in most tributaries throughout all subasins where surveyed. Low stream pool frequency and shallow pool depth coincide with contemporary fisheries studies showing predominantly young of the year steelhead populations and absence of coho. This contrasts with the earliest fisheries studies showing deeper and more frequent pool structure with consistent coho observations and older steelhead found in many of these same areas.

Sediment conditions in the stream channels along with the declining anadromous salmonid fishery prompted a USEPA listing as impaired by sediment on the Clean Water Act Section 303(d) list in 1992, with the North Coast Regional Water Quality Control Board following suit during a subsequent listing. Sediment conditions in the Gualala River watershed appear to have recovered significantly from the 1964 flood event, however data from 1992-2001 show improvement in only a few of the areas sampled. Though data were limited in geographic area, and often insufficient to show temporal or spatial trends, streambed particle sizes are relatively small in the areas sampled. The data were not analyzed spatially to provide a broader perspective of the watershed, a limitation of the assessment due to staffing resources and timelines

Water temperature data provided by Gualala River Watershed Council and Gualala Redwoods Inc. from continuous recording devices were assessed from 1994-2001. Water temperatures expressed as the highest of the floating weekly average for the summer (MWAT) were within the proposed "fully suitable" range of 50-60 F (10 to 16 C) in many tributaries in the North Fork subbasin, and in some other small tributaries in other subbasins. Mainstem water temperatures for the larger streams (North Fork, Rockpile, Buckeye, Wheatfield Fork, and South Fork/Main Gualala) were above that range. In some areas, higher water temperatures were observed coming off the Franciscan Central Belt areas where open oak woodlands predominate, then cooling as the colder tributaries contributed their flow. The extent to which this is natural is unknown.

Canopy cover was complete in most tributaries as of 1942 indicating advanced regeneration from original old growth logging. Streams in the eastern portion of the Gualala basin have a naturally more open canopy even in 1942 photos. Aerial photos from 1961, 1963, 1965, and 1981 show canopy closure substantially reduced. In 2001, measurements taken during habitat inventory surveys showed greater and improved canopy closure. Aerial photos from 1999 and 2000 substantiate these findings. Most current riparian overstory conditions reflect shade canopy in-growth of young conifer/ hardwood regeneration from riparian zones entirely cleared of all vegetation between 1952 and 1968.

The relative lack of large wood in the stream channels was noted, though landowners are adding wood under various local, state, and federal grant programs. Improved habitat complexity and sediment metering in the channels is expected to result from large-wood installation; thus enhancing the future suitability for salmonids.

EMDS: A Tool for Synthesis

The NCWAP team is using computer models called knowledge base or expert systems. The software allows scientists to combine data of different environmental factors, such as stream temperature and substrate composition, to produce a synthesis of watershed conditions for native salmonids. The data that is fed to the knowledge base network comes from GIS (Geographic Information Systems) layers developed for the program.

EMDS will rank the environmental factors by their influence on the overall habitat indicator values derived, and will show which factors, with more complete and comprehensive data, would improve the quality of the analysis in the most cost-effective manner. Maps depicting those factors that may be the largest impediments, as well as those areas where conditions are very good, can help guide protection and restoration strategies

The software assists open communication with the general public about how the scientists define suitable conditions for salmonids, and produces simple graphics and easily understood flow diagrams. Another feature of the system is that can be test the sensitivity to different assumptions about the environmental factors and how they interact.

Subbasin Issue Synthesis and Recommendations

Natural variation among subbasins is at least partially a product of natural and human disturbances. Other variables that can distinguish areas, or subbasins, in larger basins include differences in elevation, geology, soil types, aspect orientation, climate, vegetation, fauna, human population, land use and other social-economic considerations. The combined complexity of large basins makes it difficult to speak about them concerning watershed assessment and recommendation issues in other than very general terms. In order to be more specific and useful to planners, managers, and landowners, the Gualala River Basin has been subdivided into five parts: the estuary and four distinct subbasins.
Issues of the five subbasins are identified. Hypotheses regarding linkages of these various factors and processes along with supporting and contradictory findings are presented. Recommendations based on those hypotheses range from road abandonment /upgrades to expanding existing monitoring activities.

Gualala Estuary

<u>Working Hypothesis:</u> The present state of estuarine habitat is limiting the production of salmonids in Gualala River.

<u>Supporting Findings</u>: In progress.

<u>Contrary Findings</u>: None noted.

<u>Potential Recommendations:</u>

- Encourage present estuary assessment program and provide technical assistance when necessary.
- Develop long term temperature monitoring program.
- Continue and/or expand monitoring anadromous salmonid population efforts.
- Work with responsible agencies, the Gualala River Watershed Council and landowners to improve physical structure and biologic function of the estuary.
- Continue efforts such as road improvements and decommissioning throughout the basin to reduce sediment delivery to Gualala River and its tributaries.
- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Gualala River and its tributaries. Where current canopy is inadequate and site conditions are appropriate,

use tree planting and other vegetation management techniques to hasten the development of denser and more extensive riparian canopy.

North Fork Subbasin

<u>Working Hypothesis:</u> Water temperatures in the mainstem North Fork Subasin are not fully suitable for anadromous salmonids. Depleted overstory shade canopy cover along the North Fork and tributaries from legacy harvests continues to contribute to elevated water temperatures.

<u>Supporting Findings</u>**:**

- MWATs exceeded the fully suitable range of 50-60 F at all eight North Fork mainstem sites for the period of record (1994-1998, 2000-2001), ranging from 62-72 F.
- Seasonal maxima exceeded the 75 F lethal maximum 40% of the time during the same period of record, ranging from 66-80 F.
- The highest MWATs for the period of record presented on a LandSat vegetation layer (Figure xx) point out: Water temperatures are higher in the upstream areas draining the northeastern portion. Vegetation in the area upstream of those high temperatures (Franciscan melange) is open oak grasslands with poor canopy
- Two historical timber harvest eras eliminated riparian shade canopy throughout the lower and middle reaches of the North Fork: 1860 to 1900, and 1952 to 1968, elevating stream temperatures as measured today in the latter, and presumed in the former.
- There is partial riparian cover in the oak woodland melange in the upper basin reaches.

<u>Contrary Findings</u>**:** Advanced conifer hardwood regeneration since 1968 has reinstated canopy cover throughout many of the highest tributary reaches.

<u>Limitations</u>:

- Data from Gualala Redwoods Inc.'s eight mainstem sites in about the lower 9 miles were evaluated. The North Fork mainstem is about 10 miles long, with headwater tributaries extending about another 11 miles. Data represents about 50% of total blue line length.
- The extent of the thermal reaches for the sites is unknown.
- Three sites had only one year's data.
- Raw data were not evaluated for inconsistencies, thus assumptions were made that GRI and GRWC performed quality assurance and quality control.
- Individual canopy measurements for the entire watershed were not available, Landsat 1994 layers from the US Forest Service were used instead

<u>Conclusions:</u> The hypothesis is supported, given the limitations.

<u>Recommendations</u>:

- Investigate the availability and quality of other data for the northeastern area. Include and reevaluate the hypothesis.
- More temperature, monitoring and canopy ground-truthing on the northeastern area would assist in further describing the relationship.
- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to the North Fork and its tributaries.
- Where current canopy is inadequate, use tree planting and other vegetation management techniques to hasten the development of denser riparian canopy.

<u>Working Hypothesis:</u> Stream reach conditions in the North Fork subbasin are limiting the suitability for sustaining healthy populations of native anadromous salmonids in specific areas.

<u>Supporting Findings:</u>
The EMDS reach model results indicate the following:

- Pool Shelter Complexity is low in Doty Creek and the Little North Fork upstream of Log Cabin Creek; very low in the Dry Creek tributary and in the Little North Fork from (and including) Log Cabin Creek downstream to the confluence with the North Fork; extremely low in Dry Creek downstream of the three tributary confluence and in the mainstem North Fork for the entire survey area from upstream of Dry Creek downstream to the confluence with the South Fork Gualala.

- Pool Quality rating is low in Robsinson Creek; very low in Dry Creek tributary, the little North Fork, Doty Creek; extremely low in Dry Creek below the three tributary confluence.
- Pool depth was rated extremely low in the Little North Fork watershed, Robinson Creek Dry Creek, and McGann Gulch.
- In-channel conditions were rated low in all watersheds within the subbasin, with the exception of the Mainstem North Fork.
- Embeddedness was high in the surveyed section of Robinson Creek, and very high in the surveyed section of Doty Creek.
    - Canopy Density is: Low in Dry Creek downstream of the three tributary confluence and in the surveyed section of Robinson Creek.Very low in the upper two-thirds of the surveyed section of the Dry Creek tributary.

Contrary Findings:
The EMDS reach model results indicate the following:

- Pool Shelter Complexity was rated barely suitable in the surveyed section of Robinson Creek.
- Pool Quality is somewhat suitable in the surveyed section of the mainsteam North Fork.
- Pool Depth is fully suitable in the surveyed section of the mainsteam North Fork.
- In-channel conditions are somewhat suitable in the surveyed section of the mainsteam North Fork.
- Embeddedness was low to very low in the subbasin, with the exception of Robinson Creek, Doty Creek, and McGann Gulch.
- Canopy Density is mostly suitable in the surveyed section of the mainsteam North Fork, and fully suitable in the Little North Fork subwatershed.

Limitations: Not all tributaries in the subbasin were surveyed.

Conclusions: Hypotheses are supported given the stated limitations.

Recommendations:

- Restoration activities should focus on areas needing improved pool quality, and on improving canopy density in Robinson and Dry Creeks.

***Working Hypothesis:* A lack of in-stream large woody debris contributes to simplified riparian habitat structure (e.g., lack of large, deep pools)**

Supporting Findings:

- Heavy tractors which built roads, landings, and skid trails in or adjacent to streams between 1952 and 1968 buried, removed, or dispersed large woody debris in the basin.
- Historic and recent timber harvest in lower and middle reaches frequently removed large conifer vegetation down to the stream bank, reducing the available recruitment supply of large woody debris.
- Although stream buffers are regenerating under current land management practices and Forest Practice rules, dense buffers of conifers large enough to function, upon recruitment, as large woody debris in channel formation processes have not yet been reestablished.
- Cleaning of streams to remove “fish barriers” made of large woody debris occurred throughout the subbasin.

Contrary Findings: None noted.

Limitations: None noted.

Conclusions: Hypotheses are supported given the stated limitations.

Recommendations:

- Gualala River Watershed Council and Gualala Redwoods Inc. are encouraged to do more large woody debris placement work throughout the N.F. basin. .
- Tree planting, thinning from below, and other vegetation management techniques will hasten the development of large riparian conifers.

<u>Working Hypothesis:</u> Due to the steep topography of the NF basin, many roads are located in erosion-prone areas, such as, adjacent to stream channels or across debris slide slopes.

<u>Supporting Findings:</u>
- Debris slides and debris flows are very common in this subbasin. Delivery of that sediment to watercourses is high.
- Road density and stream density in the upper NF basin is the highest in the Gualala watershed [EMDS results]. This combination results in a high number of stream crossings. The steep topography and high stream density result in intense, flashy runoff, and frequent debris flows that challenge poorly engineered stream crossings.
- Mapping and aerial photo analysis shows that legacy roads preferentially followed streams up the narrow valleys resulting in stream side canopy removal and in-stream and near-stream grading.
- The fast runoff of storm water produces high peak flows along major tributaries that challenge in-stream and near-stream road related structures.
- The 1981 photos show a high density of road and landing failures along streamside roads throughout the steep, deeply incised terrain in the Stewart Ck. Planning watershed.
- The residual effects of heavy channel aggregation from streamside road system failures built in the 1950s and 1960s is noted in timber harvest plan records in Dry , Robinson, Stewart Creeks, and McCann Gulch. These sites are confirmed on ground by CDF and DMG field inspectors.

<u>Contrary Findings</u>: None noted.

<u>Limitations</u>: None noted.

<u>Conclusions:</u> Hypotheses are supported given the stated limitations.

<u>Recommendations</u>:
- Evaluate the feasibility of abandoning streamside roads.
- Culverts should be sized to accommodate flashy, debris laden flows. Trash racks or similar structures should be used to prevent culvert plugging. Critical dips should be required to minimize the impact of culvert failure.
- Existing roads systems should be maintained and new roads built in accordance to currently recognized Best Management Practices.
- Continue to decommission streamside roads and landings. The following tributaries contain the highest density of these still active sediment sources: Doty, Dry, Robinson, Stewart, and McCann Gulch.

<u>Working Hypothesis:</u> Accelerated erosion from roads has contributed to the sedimentation in the streams resulting in added degradation of salmon habitat.

<u>Supporting Findings:</u>
- Comparison of historic stream survey and electrofishing show a decline in salmon populations.
- Comparison of historic stream surveys and current habitat inventory survey showed that pools of some tributaries have become shallower and some streambeds have become embedded with fine sediment over the last several decades. Both are limiting factors to salmonids.
- Both historic and modern aerial photos show that numerous debris flows and slides involve roads and that numerous failures occur along in-stream and near-stream roads and landings. These resulted in increased sedimentation in the streams.

<u>Contrary Findings</u>:
- Embeddeness is suitable on the Northfork, Little Northfork and Log Cabin creeks.
- Embeddeness may be suitable on additional tributaries which have not been surveyed.

<u>Limitations</u>: None noted.

<u>Conclusions:</u> Hypotheses are supported given the stated limitations.

Recommendations:

- Road managers should develop and adopt erosion control plans. Repairs and new road construction should be carefully designed and when necessary licensed specialists such as civil engineers, erosion control specialists, and engineering geologists should be consulted.
- Upgrading and diligent maintenance of existing road systems to reduce sediment impacts will slow the degradation of salmon habitat –specifically pools and spawning gravel. Careful engineering of new roads or repairs can reduce adverse sediment impacts.

Rockpile Creek Subbasin

***Working Hypothesis:* The Rockpile subbasin provides unsuitable habitat for coho and somewhat suitable habitat for steelhead.**

Supporting Findings:

- Water temperatures in lower three miles of mainstem exceed suitable range for salmonids.

Contrary Findings:

- Improving canopy
- We have no temperature data for upstream nor for other tributaries.
- Water temperature at a tributary site was within suitable range.

***Working Hypothesis:* Many roads, in the lower Rockpile Creek basin, are located in erosion-prone areas; such as, adjacent to stream channels or across debris slide slopes. In the upper basin, active earthflow complexes are so abundant that they are unavoidably crossed by many roads.**

Supporting Findings:

- Debris slides and debris flows are very common in this subbasin. Delivery of that sediment to watercourses is high.
- The large portions of the upper basin are underlain with the mélange of the Central Belt of the Franciscan Assemblage and vegetated with prairie and sparse oaks. Runoff from the prairie is rapid creating potentially high peak flows. Landsliding is especially abundant in the mélange. These high flows and landsliding challenge poorly engineered stream crossings.

Contrary Findings: None at this time.

Limitations: Field level analysis of sediment was limited.

Potential Recommendations:

- In the erosion-prone Rockpile Creek basin, careful road siting, design, and maintenance is necessary to avoid increased sedimentation of streams because poorly sited or engineered roads will likely produce sediment impacts to stream.
- Evaluate the feasibility of abandoning streamside roads.
- In steep terrain, culverts should be sized to accommodate flashy, debris laden flows. Trash racks or similar structures should be used to prevent culvert plugging. Critical dips should be required to minimize the impact of culvert failure.
- Existing roads systems should be maintained and new roads built in accordance to currently recognized Best Management Practices.

***Working Hypothesis:* Accelerated erosion from roads has contributed to the sedimentation in the streams resulting in added degradation of salmon habit.**

Supporting Findings:

- Comparison of modern and historic stream surveys show a decline in salmon populations.
- Comparison of modern and historic stream surveys show that some pools have become shallower and streambeds have become embedded with fine sediment over the last several decades. Both conditions are deleterious to salmon.

- Both historic and modern aerial photos show that numerous debris flows and debris slides involve roads and that numerous failures occur along in-stream and near-stream roads and landings. These resulted in increased sedimentation in the streams.

Contrary Findings: None at this time.

Limitations: Field level analysis of sediment delivery was limited.

Conclusions:

- Upgrading and diligent maintenance of existing road systems to reduce sediment impacts will slow the degradation of salmon habitat –specifically pools and spawning gravels.
- Careful engineering of new roads or repairs can reduce adverse sediment impacts

Potential Recommendations:

- Road managers should develop and adopt erosion control plans.
- Repairs and new road construction should be carefully designed and when necessary licensed specialists such as civil engineers, erosion control specialists, and engineering geologists should be consulted.

Working Hypotheses: Accelerated erosion from logged areas has contributed to the sedimentation in the streams resulting *in added degradation of salmon habit.*

Supporting Findings

- Comparison of modern and historic stream surveys show a decline in anadromous populations

- Comparison of modern and historic stream surveys show that pools have become shallower and streambeds have become embedded with fine sediment over between the earliest fisheries surveys between 1964 and present. Both conditions are deleterious to anadromous fisheries.

- Roads and landings are important sediment sources in the basin. Both historic and modern aerial photos show that numerous debris flows and debris slides involve roads and that numerous failures occur along in-stream and near-stream roads and landings. These resulted in increased sedimentation in the streams.

- Most of the roads in the basin were built strictly to support logging operations.

- Most of the middle reaches of the Rockpile basin were clear-cut between 1952 and 1968 buillding roads in or along the major tributaries streams and mainstem Rockpile. Timber operations were particularly pronounced immediately prior to the 1964 flood. Some larger tributary stream basins only required 3 to 5 years to liquidate the timber. This left large areas of disturbed ground on steep slopes.

- The residual effects of heavy channel aggregation from streamside road system failures built in the 1950s and 1960s is noted in timber harvest plan records, particularly the Middle Rockpile Planning Watershed.

- Comparative 20 year stream channel width measurements between 1961 and 1981 show channel width widening responses to more concentrated harvests upstream.
- Large in-stream landings were built in support of logging operations. Many of these were washed out during subsequent storms.
- Modern logging operations are far less intense than those practiced from 1950-1968. In-stream roads and landings are not permitted. Tractor logging on steep slopes is now restricted. The size and degree of clear cuts is now limited. Erosion control is now mandatory for harvested areas.

Contrary Findings: None at this time.

Limitations: These conditions are well constrained within the scope of work performed thus far.

Conclusions:

- Past logging practices, specifically tractor operations on steep slopes, accelerated erosion and added excess sediment to stream channels.

- Upgrading and diligent maintenance of existing road systems to reduce sediment impacts will slow the degradation of salmon habitat –specifically pools and spawning gravels. Careful engineering of new roads or repairs can reduce adverse sediment impacts.

Recommendations

- Road managers should develop and adopt erosion control plans. Repairs and new road construction should be carefully designed and when necessary licensed specialists such as civil engineers, erosion control specialists, and engineering geologists should be consulted.
- Spread timber harvesting operations through time and space to avoid concentrated road use by heavy equipment and resultant mobilization of road surface fines accessing watercourses.
- Continue to decommission streamside roads and landings. The following tributaries contain the highest density of these still active sediment sources: Red Rock Creek, Horsethief Canyon, and larger tributary watercourses in the middle reaches of the basin flanked by McGuire Ridge between Rockpile Peak and Robinson Ridge, downstream of Burnt Ridge Creek.

***Working Hypothesis:* Depleted overstory shade canopy cover along Rockpile Ck. and tributaries from legacy harvests continues to contribute to elevated water temperatures.**

Supporting Findings:
- Heavy tractors building roads, landings, and skid trails in riparian zones shortly after WW II eliminated overstory shade canopy cover throughout long sections of Rockpile Creek and tributaries. There was near entire canopy elimination in the Middle Rockpile Planning Watershed, with operations especially pronounced during the late 1950s to 1964.

Contrary Findings:
- Advanced conifer hardwood regeneration since 1968 has reinstated canopy cover throughout many of the highest tributary reaches.

Potential Recommendations:
- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Rockpile Ck. and its tributaries.
- Where current canopy is inadequate, use tree planting and other vegetation management techniques to hasten the development of denser riparian canopy.
- Increase continuous temperature monitoring efforts.

***Working Hypothesis:* A lack of in stream large woody debris contributes to simplified riparian habitat structure (e.g., lack of large, deep pools).**

Supporting Findings:
- Heavy tractors building roads, landings, and skid trails in or adjacent to streams between 1952 and 1968 buried, removed, or dispersed LWD in the basin. Field observations have confirmed low LWD distributions.
- Historic and recent timber harvest in lower and middle reaches frequently removed large conifer vegetation down to the stream bank, severely reducing the available recruitment supply of large woody debris.
- Although stream buffers are regrowing under current land management practices and Forest Practice rules, dense buffers of conifers large enough to function, upon recruitment, as LWD in channel formation processes have not yet been reestablished.

Contrary Findings: None noted.

Limitations: Limited formal stream reach surveys have been done for LWD; however observations of crews and findings regarding pool complexity indicate that there is limited instream LWD.

Potential Recommendations:
- Artificial LWD installation projects vastly speed up in channel diversity development

- Tree planting, thinning from below, and other vegetation management techniques will hasten the development of large riparian conifers.

Buckeye, Wheatfield and South Fork Subbasins

The following working hypotheses are still being explored for these subbasins. The NCWAP team will work with the public and stakeholders during the revision period to finalize analyses, draw conclusions about the level of support of findings, and develop appropriate recommendations.

***Working Hypotheses:* The subbasins provide unsuitable habitat for coho and somewhat suitable habitat for steelhead.**

Findings:

- EMDS results and temperature data still being analyzed.

Contrary Findings:

- Improving canopy for Buckeye subbasin.

Potential Recommendation:

- Survey ability was limited by landowner access. Agency Biologists and the Gualala River Watershed Council should consider training landowners to conduct habitat inventory and fisheries surveys.

Working Hypotheses: Accelerated erosion from logged areas has contributed to the sedimentation in the streams resulting in added degradation of salmon habit.

Supporting Findings

- Comparison of modern and historic stream surveys show a decline in anadromous populations.
- Comparison of modern and historic stream surveys show that pools have become shallower and streambeds have become embedded with fine sediment over between the earliest fisheries surveys between 1964 and present. Both conditions are deleterious to anadromous fisheries.
- Roads and landings are important sediment sources in the basin. Both historic and modern aerial photos show that numerous debris flows and debris slides involve roads and that numerous failures occur along in-stream and near-stream roads and landings. These resulted in increased sedimentation in the streams.
- Most of the roads in the Buckeye basin were built strictly to support logging operations.
- Most of the middle reaches of the Buckeye basin and the lower and middle reaches of the Wheatfield were clear-cut between 1952 and 1968, building roads in or along the major tributaries streams and mainstem Buckeye. Some larger tributary stream basins only required 3 to 5 years to liquidate the timber. This left large areas of disturbed ground.
- Conifer block removal, followed by permanent conversion to pastureland, in mainstem subbasin was the dominant historical land use practice in the basin.. Prolonged cattle encroachment into streams prevented timely riparian canopy reestablishment, reducing vegetation barriers to erosion.
- The residual effects of heavy channel aggregation from streamside road system failures built in the 1950s and 1960s is noted in timber harvest plan records, particularly the middle reaches in the Buckeye basin and the lower reaches of the Wheatfield.
- Comparative 20 year stream channel width measurements in Buckeye and Wheatfield subbasins between 1961 and 1981 show channel width widening responses to more concentrated harvests upstream.
- Large in-stream landings were built in support of logging operations. Many of these were washed out during subsequent storms.

- Past logging practices, specifically tractor operations on steep slopes, accelerated erosion and added excess sediment to stream channels.

Contrary Findings:

- Modern logging operations are far less intense than those practiced from 1950-1968. In-stream roads and landings are not permitted. Tractor logging on steep slopes is now restricted. The size and degree of clear cuts is now limited. Erosion control is now mandatory for harvested areas.
- Building fences along creeks, now highly encouraged by Resource Conservation Districts, is being implemented more widely on private ranches.

Limitations: Field work related to sediment delivery is limited.

Potential Recommendations

- Upgrading and diligent maintenance of existing road systems to reduce sediment impacts will slow the degradation of salmon habitat –specifically pools and spawning gravels. Careful engineering of new roads or repairs can reduce adverse sediment impacts.
- Road managers should develop and adopt erosion control plans. Repairs and new road construction should be carefully designed and when necessary licensed specialists such as civil engineers, erosion control specialists, and engineering geologists should be consulted.
- Spread timber harvesting operations through time and space to avoid concentrated road use by heavy equipment and resultant mobilization of road surface fines accessing watercourses.
- Continue to decommission streamside roads and landings. The following tributaries contain the highest density of these still active sediment sources:
    - Franchini, Grasshopper, and Osser Creeks in Buckeye
    - Lower reaches of House, Haupt and Tobacco Creeks, North Fork Wheatfield Fork Mckenzie Creek on South Fork main stem.

***Working Hypothesis:* Depleted overstory shade canopy cover along Buckeye Creek and Wheatfield Forks, and the higher reaches of Upper South Fork and Marshall Creek and their tributaries from legacy harvests continues to contribute to elevated water temperatures. In the mainstem these effects were followed by conversion to grazing.**

Supporting Findings:

- Heavy tractors building roads, landings, and skid trails in riparian zones shortly after WW II eliminated overstory shade canopy cover throughout long sections of Buckeye Creek, Wheatfield Fork, Upper South Fork and Marshall Creek and tributaries.
- Vineyard development in recent times in the mainstem may have encroached into riparian zones.
- There was near entire canopy elimination in the middle Buckeye basin reaches with operations especially pronounced during the late 1950's to 1964, and in lower mainstem and main tributaries of Wheatfield, particularly in the 1950's.

Contrary Findings:

- Advanced conifer and hardwood regeneration since 1968 has reinstated canopy cover through out many of the highest tributary reaches.

Potential Recommendations:

- Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to Buckeye Ck, Wheatfield Fork. and their tributaries.
- Where current canopy is inadequate, use tree planting and other vegetation management techniques to hasten the development of denser riparian canopy.
- Increase continuous temperature monitoring efforts.
- Exclude vineyard development from riparian areas on Mainstem.
- Encourage livestock exclusionary measures along streams in Mainstem.

***Working Hypothesis*: A lack of in stream large woody debris contributes to simplified riparian habitat structure (e.g., lack of large, deep pools).**

Supporting Findings:

- Heavy tractors building roads, landings, and skid trails in or adjacent to streams between 1952 and 1968 buried, removed, or dispersed LWD in the basin. Field observations have confirmed low LWD distributions.

- Historic and recent timber harvest in lower and middle reaches frequently removed large conifer vegetation down to the stream bank, severely reducing the available recruitment supply of large woody debris.
- Although stream buffers are regrowing under current land management practices and Forest Practice rules, dense buffers of conifers large enough to function, upon recruitment, as LWD in channel formation processes have not yet been reestablished.

Contrary Findings: None noted at this time.

Limitations: Limited formal stream reach surveys have been done for LWD; however observations of crews and findings regarding pool complexity indicate that there is limited instream LWD.

Potential Recommendations:

- Artificial LWD installation projects vastly speed up in-channel diversity development
- Tree planting, thinning from below, and other vegetation management techniques will hasten the development of large riparian conifers.